SMART SYSTEM OF ULTRASONIC CAR PARKING

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ABSTRACT

With the development of automobile industry, the number of private cars is greatly increasing. Correspondingly, the number of rookie drivers is increasing as well. For the rookie drivers, how to backing is always a troublesome operation. Many of them complained that their valuable cars are easily got damaged by obstacles that are hardly seen through their rearview mirror. So in this project, a new type system has been designed: smart system of ultrasonic car parking with different display mode, audio mode and smart mode:

i. Liquid crystal display (LCD) display modes: Used to display the zone of your car based on condition that have been set.
ii. LED display modes: Ordinary display modes. 6 LEDs are used to display the distance of obstacles. The more LEDs are lightening, the closer obstacles are.
iii. A buzzer or a beeper which is a signaling device is used to show the distance of the car with the obstacles behind it. The faster tone of the beep of buzzer means the distance of obstacles and car are closer.
iv. Smart mode: The engine will automatically stop if the car is in stop zone which mean it is dangerous condition to parking the car.

The ultrasonic sensor used in security technology such as car collision avoidance and distance measurement, is the best device can be used in detecting obstruction behind the car when backing up. In this paper, we analyze the interference of ultrasonic signal when transmitting and receiving, and then resolve it by software. There is a blind area and distance limitation in ultrasonic distance measurement. The result of project shows that the system's efficiency is not 100% successfully because of error of the ultrasonic sensor sensitivity itself. The system cannot display the exact distance between car and the obstacle although the entire output modes are successfully functioning.

TABLE OF CONTENTS

CHAPTER 1

INTRODUCTION

1.1 Introduction

Presently, the detection technique of laser, radar, infrared ray and ultrasonic have been widely applied at the aspects of safety technique of car collision avoidance and distance measurement. At the aspect of collision avoidance laser, radar and infrared ray are commonly applied to measure the control range between two cars and the range which should be measured behind the car. At the aspect of distance measurement the technique of ultrasonic is applied to measure the detection range when a car change the driveway and to detect the obstruction behind the car when backing up or parking. Because of the expensive price, the distance measurement system of backing up with the technique of laser and radar is only set on the minority of slap-up cars, so the research of the distance measurement system of backing up with high ratio of capability and price for the medium cars and the low-end cars is an important task of auto-electron industry.

The Smart System of Ultrasonic Car Parking introduced in this thesis can automatically measure the distance between the trail of the car and detect the obstruction behind the car, further more it can show the distance and give a sound-light alarm in real time, so it can ensure the car to run safely and reduce the accident ratio. With this system, the driver can know either he is in safe zone, warning zone or stop zone to parking your car. If his car is in some distance in stop zone, your car engine will stop automatically to avoid unpredicted thing from happen. It also suitable to be applies to van and small lorry. The driver does not need to intermeddle in or manipulate this system.

This system will have a prosperous application prospect. It will cut a way through the market of the medium cars and the low-end cars and provide a new research method for the car collision avoidance. When the electric signal is imported into the transmitter, the transmitter transmits ultrasonic, the receiver receives the reflected wave, and the sound wave transmitting time and the distance are in direct ratio, so obtain the function of distance measurement.

1.2 Problem Statement

There are many cases of accidents occurred because reverse parking problem .These are examples of cases of the problem:

1. *Anak maut dilanggar secara tidak sengaja oleh bapa* (From Utusan Malaysia, 17th January 2002)

   KLUANG 16 Jan. - Seorang kanak-kanak, Nur Faridah Mohd. Affandi, 2 tahun, mati setelah dilanggar secara tidak sengaja oleh bapanya yang memandu kenderaan pacuan empat roda di pekarangan rumahnya di Ladang Bukit Cantik, Kahang.Menurut polis, kejadian tersebut berlaku kira-kira pukul 6 petang ketika bapa kanak-kanak itu, Affandi Isnin, 29, seorang jurutera ladang mengalihkan kenderaan tersebut selepas mencucinya di kawasan lapang berdekatan rumah.Kejadian itu disedari oleh bapa berkenaan sebaik sahaja mengundurkan kenderaannya.``Kanak-kanak itu ditemui terbaring dengan berlumuran darah pada hidung dan telinga berhampiran tayar kanan hadapan," kata polis.Anak tunggal Affandi itu kemudian dikejarkan ke Pusat Kesihatan Kahang dan disahkan telah meninggal dunia sebaik tiba di situ.

   Timbalan Ketua Polis Daerah Kluang, Deputi Supritendan Mohd. Zam Mohd. Zain mengesahkan polis menerima laporan mengenai kejadian itu daripada bapanya pada pukul 8 malam hari yang sama.Menurut beliau, kes itu disiasat mengikut Seksyen 304 A, Kanun Keseksaan kerana kecuaian menyebabkan kematian.

2. *Budak maut dilanggar lori dipandu bapa saudara* (From Utusan Malaysia, 4th March 2005)

   KUALA KANGSAR 3 Mac - Seorang kanak-kanak, Khairul Ikmal Abu Bakar, 2, maut setelah dilanggar oleh lori yang dipandu bapa saudaranya di Kampung Keruh Hilir, Padang Rengas, dekat sini pagi ini.Ketua Polis Daerah Kuala Kangsar, Supritendan Zakaria Pagan berkata, kejadian berlaku ketika bapa saudara mangsa, Mohd. Nor Shadan, 46, sedang mengundurkan lorinya di halaman rumah kira-kira pukul 10 pagi.Katanya, Mohd. Nor terasa lori itu seolah-olah lori itu tersangkut pada sesuatu dan tidak dapat bergerak.Katanya, sebaik sahaja turun dari lorinya, dia mendapati Khairul Ikmal terperosok di bawah tayar belakang lori. Menurutnya, kanak-kanak tersebut yang tinggal bersamanya, cedera parah di kepala dan dikejarkan ke klinik Padang Rengas tetapi disahkan meninggal dunia.Zakaria memberitahu, mayat Khairul Ikmal dihantar ke Hospital Kuala Kangsar untuk bedah siasat sebelum dituntut oleh keluarganya.

Statistic that show amount of accidents in Malaysia in year 2006 until 2007 (Jan - Sep):

Perangkaan Kematian Jalan Raya Bagi Tahun 2006 Hingga 2007 (Jan - Sep)

Kategori Pengguna	2006	%	2006 (Jan-Sep)	2007 (Jan-Sep)	Perbezaan	%
Pemandu / Penumpang Motokar	1,215	19.3	920	1113	-193	21.0
Penunggang / Pembonceng Motosikal	3,693	58.7	2,736	2476	-260	-9.5
Pejalan Kaki	595	9.5	438	482	44	10.0
Penunggang / Pembonceng Basikal	242	3.8	183	141	-42	-23.0
Pemandu / Penumpang Bas	39	0.6	26	64	38	146.2
Pemandu / Kelindan Lori	229	3.6	174	145	-29	-16.7
Pemandu / Kelindan Van	103	1.6	73	101	28	38.4
Pemandu / Kelindan Pacuan 4 Roda	110	1.7	73	65	-8	-11.0
Lain-Lain Kenderaan	61	1.0	48	59	11	22.9
Jumlah	6,287	100	4,671	4,646	-25	-0.5

Table 1.1: Accident Statistic (Source by PDRM)

From the research, there are a few factors why the accidents occurred because reverse parking problem happened:

1. Drivers fail to detect if there any obstacle behind the car.
2. The common alarm system is not efficient.
3. Driver unable to determine the distance between the car and an obstacle behind it.

In conclusion, Smart System of Ultrasonic Car Parking is a complete system which is needed by each driver to make sure their driving is safe and to prevent accident that caused by parking problem from happened.

1.3 Objectives

The objective of this project are:

1. To determine the distance between car with an obstacle behind it.
2. To inform the driver the state of car condition either they are in safe, warning or stop zone through the colors of LED and display of LCD.
3. The car engine will stop automatically if the car is in stop zone.

1.4 Scope of project

There are several scopes that need to be proposed for the project. Those are:

i. Car
ii. Van
iii. Small lorry

1.5 Outline Thesis

This thesis consists of six chapters. In Chapter 1, the explanation for the project will be given in a general term. The objectives of the project will be elaborated. It is followed by the exploration in microcontroller field with a basic coverage of the general knowledge on microcontroller.

Chapter 2 contains literature reviews that have relation with this project. Explanation will be based on comparison, effect and contribution of some device that have been used in this project. Some practical approach in this project will also be discussed.

In Chapter 3, hardware design is explained in detail. The explanation will be given separately according to the function of the board. Explanation will be given in a more technical way and specific terms.

In Chapter 4, hardware and software design and implementation are discussed. Source code will be published in the thesis.

In Chapter 5, the result, discussion and analysis are discussed. The strengths and weakness of the Smart System of Ultrasonic Car Parking will be discussed. Improvement or future enhancement will be explained to ensure this will benefit to the people.

Chapter 6 will conclude the final of the project. The contents include the experience and the knowledge gained during accomplishing this project. Furthermore, a few recommendations will also be suggested.

CHAPTER 2

LITERATURE REVIEW

2.1 Microcontroller

A microcontroller is an integrated chip that is often part of an embedded system. The microcontroller includes a CPU, RAM, ROM, I/O ports, and timers like a standard computer, but because they are designed to execute only a single specific task to control a single system, they are much smaller and simplified so that they can include all the functions required on a single chip.

A microcontroller differs from a microprocessor, which is a general-purpose chip that is used to create a multi-function computer or device and requires multiple chips to handle various tasks. A microcontroller is meant to be more self-contained and independent, and functions as a tiny, dedicated computer.

The great advantage of microcontrollers, as opposed to using larger microprocessors, is that the parts-count and design costs of the item being controlled can be kept to a minimum. They are typically designed using CMOS (complementary metal oxide semiconductor) technology, an efficient fabrication technique that uses less power and is more immune to power spikes than other techniques.

There are also multiple architectures used, but the predominant architecture is CISC (Complex Instruction Set Computer), which allows the microcontroller to contain multiple control instructions that can be executed with a single macro instruction. Some use a RISC (Reduced Instruction Set Computer) architecture, which implements fewer instructions, but delivers greater simplicity and lower power consumption.

Early controllers were typically built from logic components and were usually quite large. Later, microprocessors were used, and controllers were able to fit onto a circuit board. Microcontrollers now place all of the needed components onto a single chip. Because they control a single function, some complex devices contain multiple microprocessors.

Microcontrollers have become common in many areas, and can be found in home appliances, computer equipment, and instrumentation. They are often used in automobiles, and have many industrial uses as well, and have become a central part of industrial robotics. Because they are usually used to control a single process and execute simple instructions, microcontrollers do not require significant processing power.

2.2 Application of Microcontroller

Microcontrollers are typically used where processing power isn't so important. Although some of you out there might find a microwave oven controlled by a UNIX system an attractive idea, controlling a microwave oven is easily accomplished with the smallest of microcontrollers. On the other hand, if he or she putting together a cruise missile to solve the problem of his or her neighbor's dog barking at 3 in the morning, he or she will probably need to use processors with a bit more computing power.

Embedded processors and microcontrollers are used extensively in robotics. In this application, many specific tasks might be distributed among a large number of controllers in one system. Communications between each controller and a central, possibly more powerful controller (or micro/mini/mainframe) would enable information to be processed by the central computer, or to be passed around to other controllers in the system (Barr, 1997).

A special application that microcontrollers are well suited for is data logging. Stick one of these chips out in the middle of a corn field or up in a balloon, and monitor and record environmental parameters (temperature, humidity, rain, etc). Small size, low power consumption, and flexibility make these devices ideal for unattended data monitoring and recording.

2.3 Drivers Behavior

Shinar (1999) reports a strong association between environmental conditions and driver behavior. He has reported a fairly strong relationship between the length of the red phase and length of the green phase at an intersection, on the one hand, and the tendency for drivers either run a red light or honk their horns when they are delayed by a vehicle that fails to proceed when the light turns green. In parking perspective, drivers are tending to parking in such dangerous way without thinking first (Yagil, 1998).This action may cause harm to another people or traffic violation.

There are more than 2, 500 cases of accidents happened cause by car parking error (Beirness, 1996) every year in U.S.A. Year by year, the statistic of the accidents suddenly increasing. Many actions had be taken to reduce this problem but there no one that so efficient recently. Until now, there are many agencies try to take step to overcome the problem by design new systems that hopefully can help the driver while parking their car and make awareness campaigns in government department, private agencies and colleges.

2.4 Understanding Ultrasonic

Ultrasonic signals are like audible sound waves, except the frequencies are much higher. The ultrasonic transducers have piezoelectric crystals which resonate to a preferred frequency and convert electric energy into acoustic energy and vice versa (Watson, 2006).

The illustration in Figure 2.1 shows how sound waves, transmitted in the shape of a cone, are reflected from a target back to the transducer. An output signal is produced to perform some kind of indicating or control function. A minimum distance from the sensor is required to provide a time delay so that the "echoes" can be interpreted. Variables which can affect the operation of ultrasonic sensing include: target surface angle, reflective surface roughness or changes in temperature or humidity. The targets can have any kind of reflective form - even round objects.

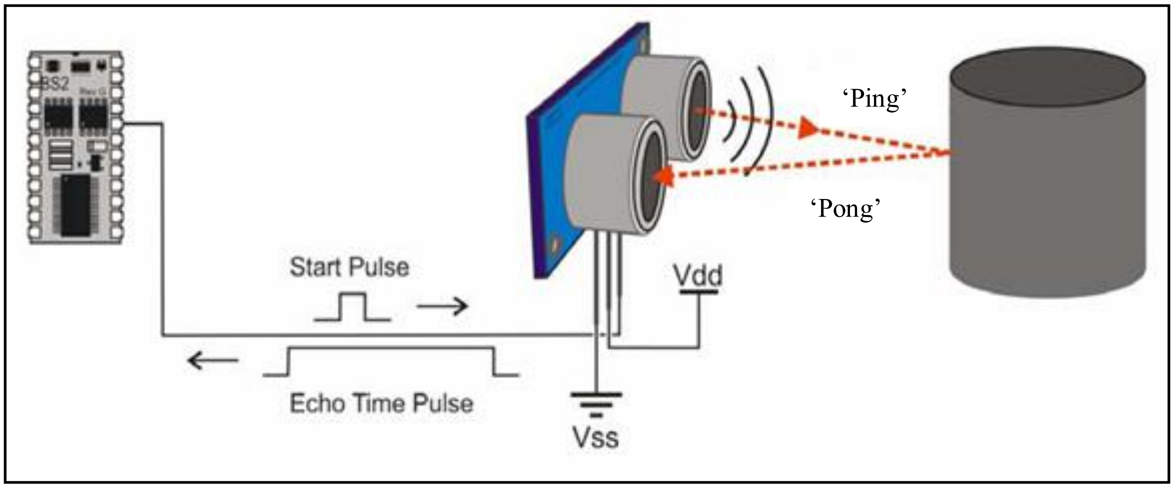

Figure 2.1: Basic concepts of 'ping' and 'pong'

When used for sensing functions, the ultrasonic method has unique advantages over conventional sensors such as infrared or reverse sensor (Larson, 1960):

a. Discrete distances to moving objects can be detected and measured.
b. Less affected by target materials and surfaces, and not affected by color. Solid-state units have virtually unlimited, maintenance free life. Have ability to detect small objects over long operating distances.
c. Have resistance to external disturbances such as vibration, infrared radiation, ambient noise, and EMI radiation.

2.5 Smart Car

Smart car is an automobile with some artificial intelligence (or "AI") functionality (IHS Automotive News, February 23, 2006). As automation technology has progressed, especially in the decades after the invention of the integrated circuit, more and more functions have been added to automobiles, relieving the driver of much of the mundane moment-to-moment decision making that may be regarded as having made driving tedious.

The fictional car KITT (Knight Industries Two Thousand)in the television series Knight Rider is the archetypal smart car. A number of real-life vehicles have been designed, built and sold commercially that incorporate AI technology such as the Mercedes-Benz Robot Cars which have led to the development of the S-Class, a series of vehicles that are generally seen as an industry leader in new technology. A similar production example is the Lexus LS, with its object recognition pre-collision systems, self-steering Lane Keep Assist, and automated parking systems.

Advanced Parking Guidance System (APGS) is an automatic parking system first developed by Toyota Motor Corporation in 2004 for its latest Lexus models and also the Japanese market hybrid Prius models. In Europe, the APGS is marketed as the Intelligent Park Assist system. On vehicles equipped with the APGS, via an in-dash screen and button controls, the car can steer itself into a parking space with little input from the user. The latest version of APGS helps determine that the car has enough clearance for a particular space, and calculates the steering maneuvers needed for parallel or reverse parking

On the Lexus LS, the Advanced Parking Guidance System uses computer processors which are tied to the Lexus Intuitive Park Assist (sonar warning system) feature, backup camera, and two additional forward sensors on the front side fenders. The Intuitive Park Assist feature includes multiple sensors on the forward and rear bumpers which detect obstacles, allowing the system to sound warnings and calculate optimum steering angles during regular parking. These sensors plus the two additional APGS sensors are tied to a central computer processor, which in turn is integrated with the backup camera system to provide the driver parking information.

When the Intuitive Park Assist feature is used, the processor(s) calculate steering angle data which are displayed on the navigation/camera touch screen along with obstacle information. The Advanced Parking Guidance System expands on this capability and is accessible when the vehicle is shifted to reverse (which automatically activates the backup camera). When in reverse, the backup camera screen features APGS buttons which can be used to activate automated parking procedures. When the Advanced Parking Guidance System is activated, the central processor calculates the optimum parallel or reverses park steering angles and then interfaces with the Electric Power Steering systems of the vehicle to guide the car into the parking spot.

2.6 The History of LCD

The modern history of liquid crystals has been dominated by the development of electronic displays. These developments began in 1964, when Heilmeier of RCA Laboratories discovered the guest-host mode and the dynamic-scattering mode. He thought a wall-sized flat-panel color TV was just around the corner. From that point on, twisted-nematic (TN) mode, super TN mode, amorphous-Si field-effect transistor, and room-temperature liquid crystals were developed (G. H. Heilmeier, 1976).

In the beginning, liquid-crystal displays (LCDs) were limited to niche applications such as small-size displays for digital watches, pocket calculators, and small handheld devices. That all changed with the development of the notebook computer industry. In 1988, Washizuka et al. of Sharp Corporation demonstrated an active-matrix full-color full-motion 14-in display using a thin-film-transistor array. The electronics industries now recognized that Heilmeier's 25-year dream of a wall-hanging television had become reality. LCDs could be used to replace existing cathode ray tubes. Through the cooperation and competition of many electronics giants, the LCD industry was firmly established.

2.7 Car LCD Screens

Modern car LCD screens can be built small enough to fit almost anywhere in the vehicle. LCD screens are the industry standard when it comes to in-vehicle entertainment. They are used in car DVD players, navigation devices and vehicle display systems. Recent developments in LCD technology have allowed for screens to be incredibly small and still provide a sharp, clear picture.

LCD stands for Liquid Crystal Display. Liquid crystals were first discovered more than 100 years ago (Hiroshi Kawamoto, 2002). They were incredibly fascinating, but at the time they did not serve any practical purpose. It wasn't until around 1970 when something called the twisted nematic field effect was discovered that liquid crystals became viable (George W. Gray, Stephen M. Kelly, 1999). Shortly after the discovery, the first digital quartz wrist watch was developed in Japan and an industry was born.

Liquid Crystal Displays may be reflective or possess their own light source. Reflective car LCD screens are comprised of six layers. On the outside is a film which filters and polarizes light as it enters. Next comes a thin piece of glass equipped with electrodes. The shape of the electrodes dictate the dark shapes that will appear on the display. Smooth, slight vertical ridges are etched into the surface of the glass. Within the next layer are the guts of the system: twisted nematic liquid crystals. Behind the crystals another layer of glass features electrode film and a series of horizontal lines. The lines of this glass substrate match up with lines on the next layer: a horizontal filter film. The final layer is a highly reflective surface to send light back through the first five layers. The reflective layer would be a light source in a backlit LCD system.

When shopping for car LCD screens there are several factors of which to become aware. Attributes include:

• Resolution- The best indicator of picture quality, resolution is expressed in terms of pixilation. For example, a screen with a resolution of 1024 x 768 will include 1024 horizontal pixels and 768 vertical pixels.

• Viewable Size (or Active Display Area)- This is exactly what it sounds like, measured diagonally just like standard TVs. Car LCD screens as small as 2.5 inches are not unusual.

• Dot Pitch- Typically the same vertically and horizontally, this is the distance between the centers of two consecutive pixels. A shorter distance will result in a sharper picture.

• Contrast Ratio- Represents the range between the brightest bright and the darkest dark.

Many features of car LCD screens are the same as those of regular television screens. Features like brightness (also known as luminance) are measured the same way regardless of screen size or type. The aspect ratio is a measure of the relationship between width and height. An aspect ratio of 4:3 would indicate that the screen was four units across and three from top to bottom. The ratio will usually be expressed in larger numbers with larger sets because higher values allow for more detail.

2.8 Assembly Languages: Low-Level Language

An assembly language is a low-level language for programming computers. It implements a symbolic representation of the numeric machine codes and other constants needed to program a particular CPU architecture (David Salomon, 1993). This representation is usually defined by the hardware manufacturer, and is based on abbreviations (called mnemonics) that help the programmer remember individual instructions, registers, etc.

Assembly languages were first developed in the 1950s, when they were referred to as second generation programming languages. They eliminated much of the error-prone and time-consuming first-generation programming needed with the earliest computers, freeing the programmer from tedium such as remembering numeric codes and calculating addresses. They were once widely used for all sorts of programming. Today, assembly language is used primarily for direct hardware manipulation, access to specialized processor instructions, or to address critical performance issues. Typical uses are device drivers, low-level embedded systems, and real-time systems.

A utility program called an assembler is used to translate assembly language statements into the target computer's machine code. The assembler performs a more or less isomorphic translation (a one-to-one mapping) from mnemonic statements into machine instructions and data. (This is in contrast with high-level languages, in which a single statement generally results in many machine instructions. A compiler, analogous to an assembler, is used to translate high-level language statements into machine code; or an interpreter executes statements directly.)

Many sophisticated assemblers offer additional mechanisms to facilitate program development, control the assembly process, and aid debugging. In particular, most modern assemblers (although many have been available for more than 40 years already!) include a macro facility (described below), and are called macro assemblers.

2.9 Comparison of Assembly and High Level Languages

Assembly languages are close to a one to one correspondence between symbolic instructions and executable machine codes. Assembly languages also include directives to the assembler, directives to the linker, directives for organizing data space, and macros (Murdocca, Miles J.; Vincent P. Heuring, 2000). Macros can be used to combine several assembly language instructions into a high level language-like construct (as well as other purposes). There are cases where a symbolic instruction is translated into more than one machine instruction. But in general, symbolic assembly language instructions correspond to individual executable machine instructions.

High level languages are abstract. Typically a single high level instruction is translated into several (sometimes dozens or in rare cases even hundreds) executable machine language instructions. Some early high level languages had a close correspondence between high level instructions and machine language instructions. For example, most of the early COBOL instructions translated into a very obvious and small set of machine instructions. The trend over time has been for high level languages to increase in abstraction. Modern object oriented programming languages are highly abstract (although, interestingly, some key object oriented programming constructs do translate into a very compact set of machine instructions).